NASA/TP–20230003373

GATEWAY SMALL SATELLITE DEPLOYMENT APPROVAL GUIDELINES

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April 2023

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GP 10193

BASELINE

RELEASE DATE: APRIL 2023

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REVISION AND HISTORY PAGE

Revision No.	Change No.	Description	Release Date
Baseline	CR GP-C0341	Initial Release – Approved at Gateway Program Control Board (GPCB) on August 04, 2022	08/04/22

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1.0 INTRODUCTION

The issue of small payloads released from Gateway may become a concern for the space users' community. Man-made objects can stay in the same or crossing orbit for a long time, creating significant hazard for Gateway, other users and sites on the surface of the Moon.

It is important to coordinate efforts between organizations and agencies to ensure that Gateway operates safely.

1.1 PURPOSE

The purpose of this document is to outline the Gateway Program approach for evaluating the deployment of candidate research payloads from Gateway Modules and/or Visiting Vehicles (VV) docked to the Gateway or vehicles/modules on the route to/from the Gateway.

While there is no official standard or definition for a Small Satellite, the term typically refers to a spacecraft with a mass of less than 500 kg. CubeSats are better defined than any other Small Satellites using Unit sizes to describe configuration and mass. However, this definition may limit use of other Small Satellite designs on Gateway. Thus, for the purpose of this document we consider Small Satellites to be under 25 kg and not define their configuration.

1.2 SCOPE

This document outlines the required analyses and document the approval process for candidate payload deployments from the Gateway Modules/Robotic Arm, Gateway-docked Visiting Vehicles, or Gateway Logistics Services (GLS) vehicles in flight to/from Gateway. The deploy candidate is defined as any satellite payload active or passive released from the Gateway Modules or Visiting Vehicles while the vehicle is docked to the Gateway, on the way to the Gateway, or post departure from Gateway and in Near-Rectilinear Halo Orbit (NRHO) or crossing NRHO.This document also identifies the data required to initiate a candidate satellite deployment evaluation & approval by the Gateway Program team.

Candidate satellites fall under one of these two categories that are currently identified:

- Passive satellites, for which the only delta-Velocity (dV) and directional capability are achieved through the deployment mechanisms.

  No active propulsive attitude control or translational capability.

- Active satellites which can perform dV and/or directional maneuvers post deployment.

  Active attitude control and/or translational capability.

This document covers the Gateway analysis coordination process and guidelines for performing necessary analysis through the payload approval process. Payload integration as well as verification processes will be covered under GP 10037, Gateway Payload Interface Definition Document and GP <TBD-SSAT-GUIDE-0001>, Payload Integration Agreement (PIA) document. The development of Hazard Reports will be performed using a standard GISRP process as documented in GP10024, Gateway Program Hazard Analysis Requirements.

1.3 CHANGE AUTHORITY/RESPONSIBILITY

Proposed changes to this document shall be submitted via a Change Request (CR) to the appropriate Gateway Board for consideration and disposition.

All such requests will adhere to the Gateway Change Process.

2.0 DOCUMENTS

2.1 APPLICABLE DOCUMENTS

Document Number	Document Revision	Document Title
GP 10037	Current Revision	Gateway Payload Interface Definition Document
<TBD-SSAT-GUIDE-0001>	Current Revision	GP Payload Integration Agreement
GP 10053	Current Revision	Gateway Mission Design Document
GP 10109	Current Revision	Gateway Spectrum Management Plan
GP 11461	Current Revision	Gateway Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
GP 11464	Current Revision	Gateway Electromagnetic Effects (E3) Requirements

2.2 REFERENCE DOCUMENTS

Document Number	Document Revision	Document Title
GP 10024	Current Version	Gateway Program Hazard Analysis Requirements
NID 8715.128	Expiration Date: Dec 7, 2021	NASA Interim Directive: Planetary Protection Categorization for Robotic and Crewed Missions to the Earth's Moon
NPR 8715.6B	Current Revision	NASA Procedural Requirements for Limiting Orbital Debris and Evaluating the Meteoroid and Orbital Debris Environments
NID 7120.132	Expiration Date: November 19, 2021	Collision Avoidance for Space Environment Protection

3.0 GUIDELINES

While there are risks associated with satellite deployments during approach, while docked, and post mission completion, the Gateway Program recognizes that there are also significant benefits associated with conducting scientific research, technology demonstration and education.

Payloads may be deployed from a deploy mechanism installed on a Gateway-docked visiting vehicle or Gateway module or by the Robotics Arm. It is important to ensure that any planned release does not pose threat to the Gateway or other NASA assets and safely leaves the Gateway orbit.

Inadvertent releases will not be covered by this document.

It is the intent of the Gateway Program to ensure that all satellites intended for deployment from the Gateway and Logistics Vehicles at any time of the mission comply with constraints set forth by the NASA Interim Directive NID 8715.128: Planetary Protection Categorization for Robotic and Crewed Missions to the Earth's Moon, NPR 8715.6B: NASA Procedural Requirements for Limiting Orbital Debris and Evaluating the Meteoroid and Orbital Debris Environments, and NID 7120.132 Collision Avoidance for Space Environment Protection, and NPR 2570.1 NASA Radio Frequency (RF) Spectrum Management Manual.

Given a limited ability to track objects in cis-Lunar space, payloads not related to NASA are not going to be addressed in this document. However NASA expects external payload owners to provide information on their satellite ephemerides data to the Deep Space Network Service (DSN) Service Preparation subsystem (SPS) for inclusion in the Multi-mission Automated Deep Space Conjunction Assessment Process (MADCAP) screening process and comply with NID 8715.128 NASA Interim Directive: Planetary Protection Categorization for Robotic and Crewed Missions to the Earth's Moon, NPR 8715.6B NASA Procedural Requirements for Limiting Orbital Debris and Evaluating the Meteoroid and Orbital Debris Environments and NID 7120.132 Collision Avoidance for Space Environment Protection. The process of data exchange and agreements with external payload owners are currently in work

3.1 SMALL SATELLITE DEPLOY REVIEW GUIDELINES

The deploy candidate provider with consultation support from NASA teams, will be responsible for performing a series of analyses that demonstrate the safe execution of the proposed mission. Analysis results will be reviewed prior to making a decision as to whether or not a deploy candidate satellite will be approved. NASA Gateway Systems Engineering and Integration (SE&I) Office will be responsible for managing these analyses and presenting an integrated recommendation to the Gateway Program. NASA Gateway Integrated Safety Review Panel (GISRP) will be responsible for determining credible failure scenarios, identifying additional analyses required and reviewing Hazard Reports submitted by the provider in accordance with the NASA safety process. The Gateway Utilization Coordination Panel (GUCP) will be responsible for coordinating the science with International Partners. The Mission Integration and Utilization Control Board, with the sub-panel Gateway Utilization Integration Panel, will be responsible for tracking integration and manifest.

The following sections define the deploy candidate review and analysis processes.

3.1.1 Deploy Candidate Analysis Guidelines

Potential deploy candidates need to be identified at least 18 to 24 months before mission to ensure that all analyses results are reviewed by appropriate Gateway boards and forums. Once the candidate is identified, NASA Gateway SE&I Office will define types of analyses that are required for a specific candidate based on proposed mission objectives and candidate satellite design. The list of data required from a provider includes, but is not limited to:

1. Detailed description of a candidate satellite mission profile including final desired location/orbit

2. Candidate satellite properties such as mass, size, volume, shape, materials, etc.

3. Candidate satellite propulsive properties including propellant systems, translational delta-V capability, and attitude control

4. Candidate satellite communications and tracking properties, e.g., comm system

5. Proposed deploy method

    - Robotically deployed candidates require ROBOCP board approval prior to proceeding to step 6 (authorization and vetting).

6. Trajectory analysis and ephemerides

    a. Deployed payloads owners are expected to provide real-time trajectory updates to the Deep Space Network Service (DSN) Service Preparation subsystem (SPS) for inclusion in the Multi-mission Automated Deep Space Conjunction Assessment Process (MADCAP) screening process that NASA relies on for collision avoidance in cis-lunar space in accordance with NPR 87156B section 3.3.

7. Deploy attitude, direction and time

8. Detailed description of deploy mechanism

9. Details of any sub-deploys

    a. Any constituent portion of a primary payload, which can separate into its own free-flying object either intentionally or under credible failure scenarios. Examples include secondary satellite payloads, drag parachutes, tethers, harpoons, nets, probes, chip sats, etc.

10. Spectrum management analysis

11. Electromagnetic effects analysis

Once a deploy candidate has been identified, the NASA Gateway SE&I Office provides a summary of deploy candidate characteristics and proposed mission plan to Gateway SE&I/VSI Control Board (GSVCB). In coordination with GISRP, the GSVCB decides on the type of

additional analyses required from the provider, if any, in order for the Gateway Program to recommend that the deploy candidate be accepted for the mission.

The following sections define the types of analyses and data that will be required from the candidate owner. Additional analysis maybe required based on individual spacecraft and mission design.

3.1.1.1 Trajectory Analysis

The owner of the deploy candidate will be responsible for conducting trajectory analysis of the deployed satellite and providing mission details and objectives to the Gateway Program.

For payloads deployed using Robotic Arm trajectory analysis includs EVR deployment analysis due to the impact to trajectory from Robotic Arm reaction to deploy forces.

3.1.1.2 Relative Motion Analysis

The owner of the deploy candidate will have to demonstrate that deployed satellite is capable of continuing positive separation from the Gateway and eventual departure from the NRHO without activating its propulsion system. The owner will also be responsible for demonstrating that dV imparted into the satellite by the deploy mechanism, the deploy attitude and location in the orbit meet the criteria for safe departure.

The satellites that may intersect Artemis mission orbits (e.g. Low Lunar Orbit, Lunar Surface missions, NRHO missions, etc.) will have to demonstrate that they meet fault tolerance requirements similar to Gateway Visiting Vehicles to ensure that the satellite can complete mission objectives and its proposed end of mission plan.

3.1.1.3 Expedited Approval

The analysis/approval process can be expedited if the proposed deployment conforms to a set of conditions that have been pre-approved by the Gateway Program by generic analysis. Guidelines may include, but are not limited to, direction of release, orbital parameters at time of release, and deployment dV. Deploy candidates that elect to deploy within these conditions may follow a more streamlined approval process. Only passive payloads may be considered for an expedited process.

Expedited approval of EVR-based deployments rely on generic analysis performed by CSA based on a range of allowable payload masses and forcing function parameters.

NOTE: Expedited approval from Spectrum Management may not be possible for RF systems.

A specific range of deployment delta-V magnitudes, directions, and locations have been identified before and after apolune. Further details appear in GP 10053, the Gateway MDD. Recontact can be avoided even for small delta-V magnitudes about 1 m/s. Directions ensure maximum separation from Gateway.

Destination of the payload post departure cannot be guaranteed. Analysis only ensures that payload departs NRHO. Potential risk of payload return post NRHO departure still exists.

Further analysis is still required to better characterize the limitations of green zone releases including delta-V errors in magnitude and direction.

Long term trajectory analysis is desired to better understand payload behavior post NRHO departure.

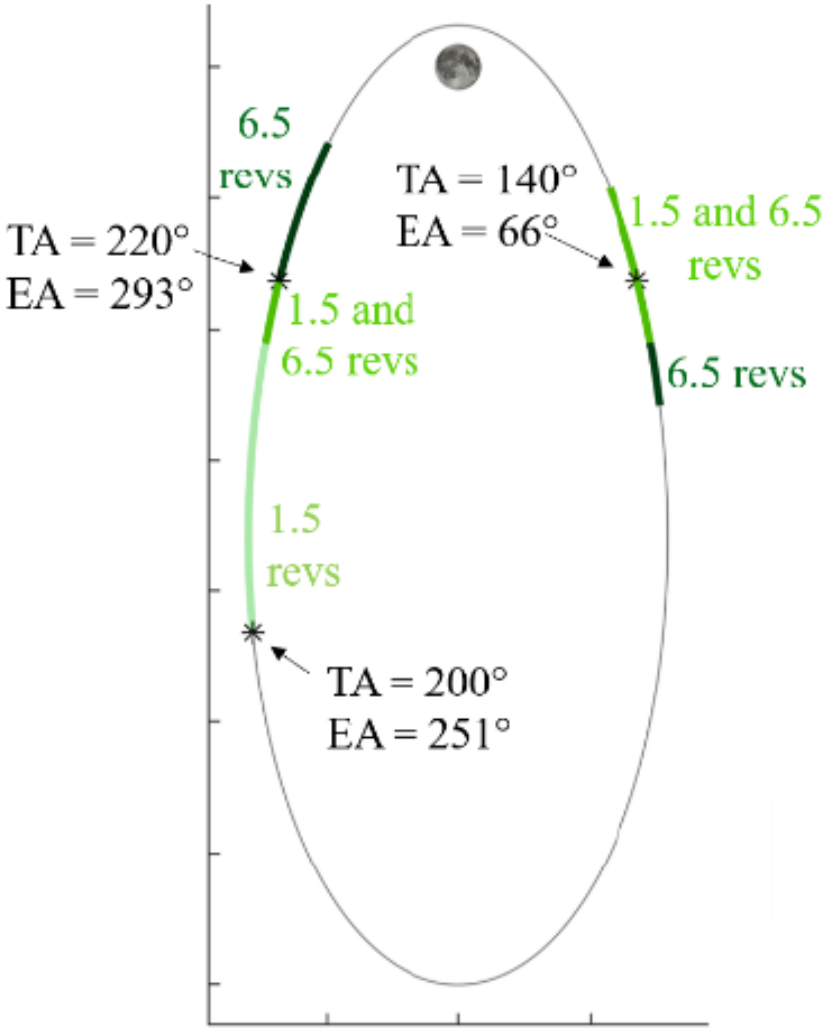

FIGURE 3.1.1.3-1 PRE-APPROVED SMALL SATELLITE RELEASE ZONES

3.1.1.4 Visiting Vehicle Traffic

The deploy satellite candidate owner is responsible for coordinating with the Gateway Program to ensure that the time of deployment does not interfere with primary Gateway objectives including upcoming approach and departure of crewed vehicles, lunar landers and other visiting vehicles/modules.

3.1.1.5 Gateway Structural Clearance

The owner of the deploy candidate in collaboration with the NASA Gateway SE&I Office and deploy mechanism provider is responsible for performing clearance analysis to ensure that orientation of the deploy mechanism, deploy velocity and trajectory, while factoring in an appropriate cone of uncertainty, allow the satellite to clear the Gateway and all attached visiting vehicle structure within 2 meters (6.56 feet)

3.1.1.6 Hazard Analysis

The owner of the deploy candidate is responsible for performing safety assessments of deploy candidate systems, hardware elements and potential contingency scenarios. Such contingency scenarios include candidate satellite system failures, deploy mechanism failures, etc. The owner of the deploy candidate is responsible for demonstrating that all systems have required levels of safety and are sufficiently fault tolerant to ensure safe execution of the mission. The provider must consider all hazards (lasers, radio frequency interference, etc.) to the Gateway and/or visiting vehicles including those defined in GP 11461 and GP 11464: Gateway Electromagnetic Effects requirements, and GP 10109: Gateway Spectrum Management Plan.

3.1.1.7 Spectrum Management Analysis

3.1.1.7.1 Spectrum Management Plan

Each Small Satellite Provider that plans to utilize RF transmissions performs assessment to ensure their compliance with the process defined in the Gateway Spectrum Management Plan AD[4] - GP 10109

3.1.1.7.2 Spectrum Management

. In coordination with Spectrum Management Providers evaluate potential interferences before procuring any RF equipment to prevent delays and/or rejectionof spectrum applications.

3.1.1.7.3 RF CLEARANCE

Upon a successful evaluation of the small satellite RF licenses, Radio Frequency Compatibility Analysis , Electromagnetic Effect Analysis, Gateway Spectrum Manager will issue an approved RF Clearance for Small Satellite Deployment from Gateway. Post deployment RF constraints may be placed on the small satellite to protect core Gateway RF links. Deployment of satellite from Gateway requires an approved RF Clearance for Small Satellite Deployment from Gateway.

3.1.1.8 Electromagnetic Effects Analysis

Small Satellite Provider ensures compliance with the processes defined in the GP 11461 and GP 11464: Gateway Electromagnetic Effects requirements GP 11461 and GP 11464. Failure to meet the requirements may impose significant operational constraints on the Payload to protect Gateway systems.

3.1.2 Deploy Candidate Approval Guidelines

Deploy analysis will be performed by the candidate owner and NASA teams and provided to the Gateway Program for review and evaluation. The Gateway Program will be responsible for identifying types of required analyses, analysis review and deploy candidate approval. It will be the responsibility of the owner of the deploy candidate/payload developer to supply analysis results and required information in a timely manner.

RoboCP (CSA) approves the deploy assessment for any robotic deployments due to the hazards posed to EVR hardware.

The GUCP will be responsible for initial assessment of proposed payloads and coordination with GPCB for initiation of payload integration coordination.

Payload integration coordination and analysis review will be performed by Gateway SE&I and vetted through the GSVCB and GISRP.

All assessments will be provided to the GISRP in the form of hazard reports in accordance with the safety review process documented in GP10024. Controls and verifications must be identified for each hazard, and the controls must ensure compliance with the requirements of this policy. Review and approval of hazard reports will be performed by the GISRP at least six months prior to candidate launch.

Once the GISRP approves a deploy candidate the integrated assessment is presented to the GPCB for final approval. For payloads deployed during Orion flight, final approval will be obtained through Gateway/Orion JPCB.

3.2 PAYLOAD INTEGRATION PROCESS

For Small Satellite process description, see Figure 3.2-1, Small Satellite Integration Process Diagram and Figure 3.2-2, Small Satellite Integration Process Description.

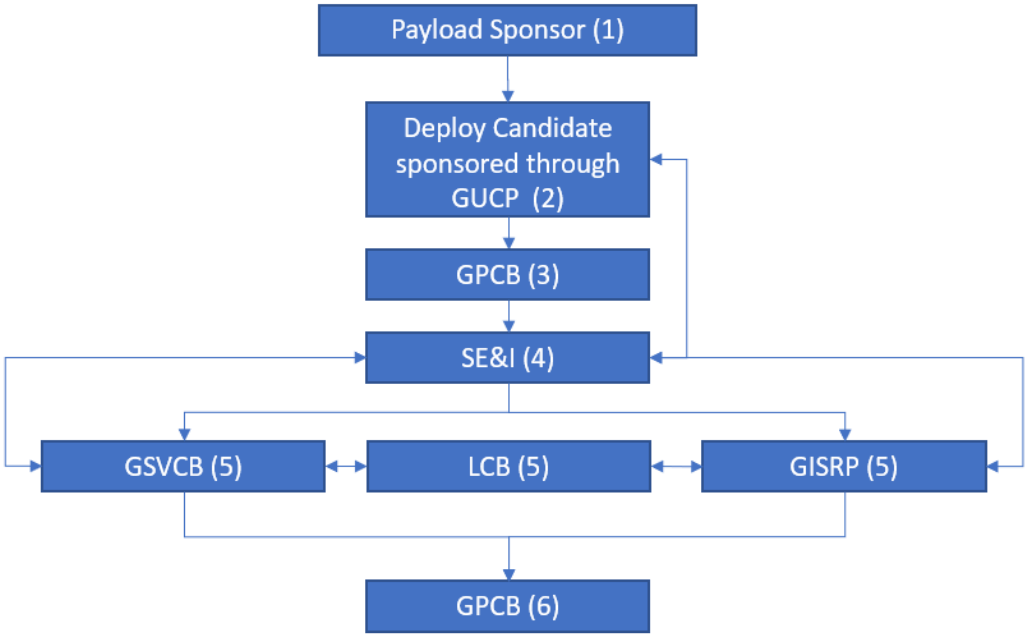

FIGURE 2 SMALL SATELLITE INTEGRATION PROCESS DIAGRAM

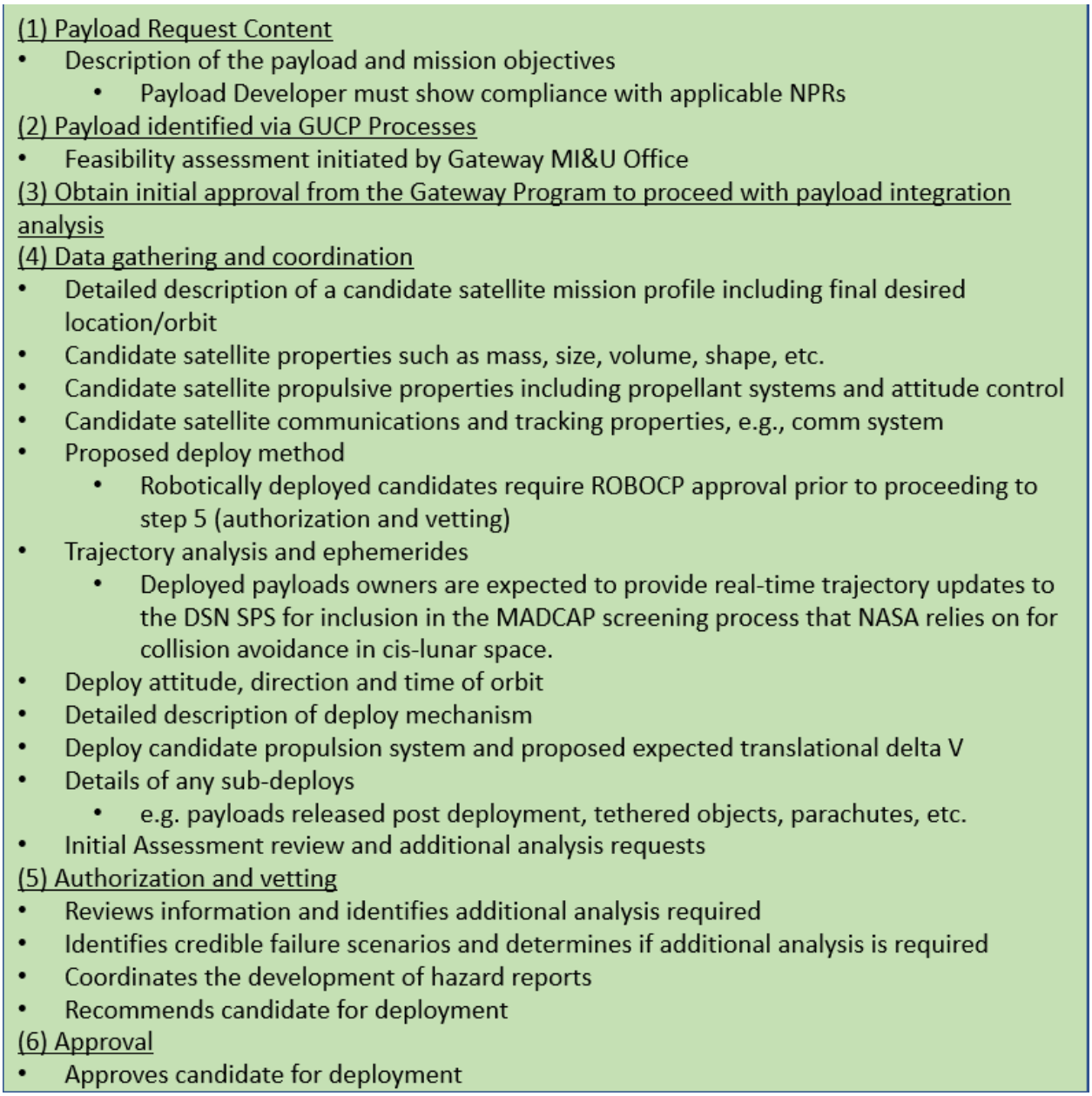

FIGURE 3 SMALL SATELLITE INTEGRATION PROCESS DESCRIPTION

APPENDIX A ACRONYMS, ABBREVIATIONS AND GLOSSARY OF TERMS

A1.0 ACRONYMS AND ABBREVIATIONS

CR	Change Request
DSL	Deep Space Logistics
dV	Delta-Velocity
EVA	Extravehicular Activity
EVR	Extravehicular Robotics
GISRP	Gateway Integrated Safety Review Panel
GLS	Gateway Logistics Services
GPCB	Gateway Program Control Board
GSVCB	Gateway SE&I/VSI Control Board
GUCP	Gateway Utilization Coordination Panel
MADCAP	Multi-mission Automated Deep Space Conjunction Assessment Process
NRHO	Near Rectilinear Halo Orbit
PIA	Payload Integration Agreement
ROBOCP	Robotics Control Panel
SE&I	Systems Engineering and Integration
SPS	Service Preparation Subsystem
VSI	Vehicle Systems Integration

A2.0 GLOSSARY OF TERMS

Term	Description
None	

APPENDIX B OPEN WORK

B1.0 TO BE DETERMINED

The table To Be Determined Items lists the specific To Be Determined (TBD) items in the document that are not yet known.

TABLE B1-1 TO BE DETERMINED ITEMS

TBD	Section	Description
<TBD-SSAT-GUIDE-0001>	2.1	GP Payload Integration Agreement (PIA) document number

B2.0 TO BE RESOLVED

The table To Be Resolved Issues lists the specific To Be Resolved (TBR) issues in the document that are not yet known.

TABLE B2-1 TO BE RESOLVED ISSUES

TBR	Section	Description
None		